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A NEW METHOD TO PREVENT ACCIDENTS IN RAILWAYS USING MICROCONTROLLER BASED ON GSM AND GPS TECHNOLOGY

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ABSTRACT

This paper is proposed to introduce a new emergency braking system in the engines also prevent accidents in narrow track turnings by Modern VCD (Vigilance Control Device), a microcontroller based safety device to prevent train accidents (due to un-alertness of engine drivers and due to speed unbalance in narrow curvatures on tracks), which will add to passenger's safety by cyclically generating warnings and by automatically stopping the train if the driver is incapacitated to control train or dead or fall asleep. This paper also informs the position of the loco crew to the higher authorities by tracking the position of the train where it is stopped by using Global System for Mobile communication (GSM) and Global Positioning System (GPS) technologies. In narrow curvature the train speed will have to manage in fraction of seconds, if driver fails VCD provide speed control and also due to improper performance of regular tasks by the driver such as accelerating or braking for a stipulated period of time, and signal inspector receives a message through GSM and also the automatic halt of the train and its position is tracked by GPS and a message will be sent to the signal inspector.

Index Terms: Train tracking system, Driver, VCD, GPS, GSM, Warnings.

1. INTRODUCTION

In Indian Railways, major accidents occur because of unseemly act or inattention of Railway staff. Higher incidence of human failures surface as technical safeguards and backups do not always replace the human effort. Though an accident occurs only when both fail but it usually gets logged as 'human error' with a tendency of glossing over technical failure. A human being is likely to commit a mistake from time to time, under optimum field conditions and with the best of intentions. Hence operating rules included many redundancies in safety procedures and operating practices involve number of checks and balances. More and more automation is resorted to prevent human errors. This paper provides a method to cyclically alert the driver for the safety of passengers. Vigilance Control

Device (VCD) is a microcontroller based safety device introduced to reduce the accidents that are caused by the pilot of the train. VCD will automatically apply penalty brakes in case the driver is incapacitated or dead which resembles similar operation in older locomotives in the form of Dead man's Lever. "The dead man's lever" is a knob that has to be pressed at all times to keep the train running. This system was introduced to prevent accidents, even if the driver died at his controls, hence the name. Unless a certain amount of pressure is maintained on the lever, brakes get automatically activated and the train slows down and comes to a stop."Dead Man System" is another form of driver safety system which detects a continuous input from the driver, e.g. by application of force to a pedal or handle [1]. In this system, higher authorities will be incapable of taking any responsible decision since the action of driver or position of the train is mysterious. So in order to overcome this disadvantage and to make the driver in alertness and to ensure safety to passengers the new system is proposed called modern vigilance control device. In this paper AT89S52 microcontroller, the heart of the system and JHD 16x2A LCD for displaying the actions and GSM modem of SIM 300 for messaging the information to the higher authorities and GPS system for tracking the position of the train after the penalty brake is applied.

In Section 2, we explain the proposed setup of the system i.e., the block diagram and its description. Section 3 explains the working of the proposed system. We conclude the paper in Section 4 describing our accomplishments.

2. BLOCK DIAGRAM AND ITS DESCRIPTION

The block diagram consists of different components interfacing to a microcontroller. The block diagram is shown in Fig.1.

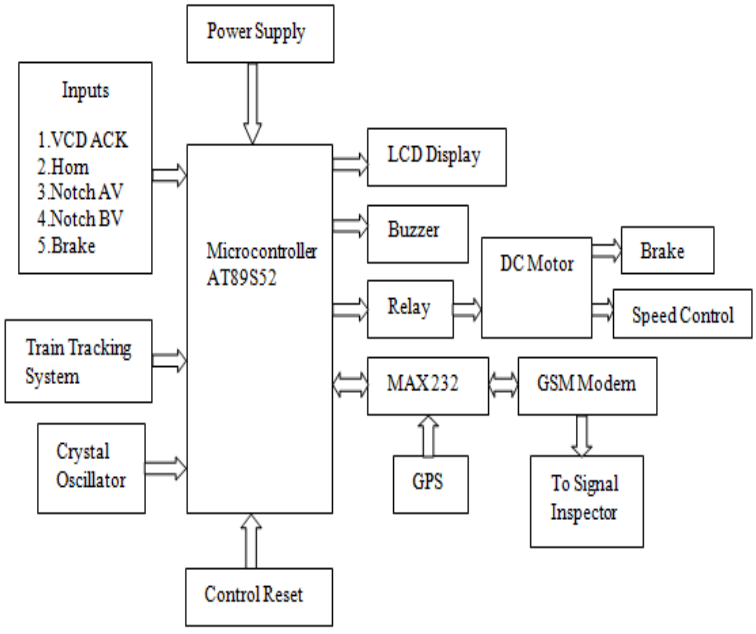

Fig.1: Block Diagram

The various components in the block diagram are mentioned below:

1. AT89S52 Microcontroller
2. Power Supply
3. Crystal Oscillator
4. Inputs
5. Control Reset
6. 16x2 Liquid Crystal Display(LCD)
7. Buzzer
8. Train Tracking system
9. Relay
10. DC Motor
11. Speed Control
12. Brake
13. MAX 232
14. GSM Modem
15. GPS Module

2.1 Microcontroller Unit

The AT89S52 with 8k bytes of in-system programmable Flash memory is a low-power, high performance CMOS 8-bit microcontroller. The device which is compatible with the industry standard 80C51 and 80C52 instruction set and pin out is manufactured using Atmel's high-density nonvolatile memory technology. With the help of on-chip Flash the program memory can be reprogrammed in-system or by a conventional nonvolatile memory programmer. The Atmel AT89S52 united a versatile 8-bit CPU with in-system programmable Flash on a monolithic chip, is a powerful microcontroller which provides a highly-flexible and cost-effective solution to many embedded control applications.

Features of the microcontroller:

1. It is a 8-bit microcontroller.
2. 8K Bytes of In-System Programmable (ISP) Flash Memory.
3. Fully Static Operation: 0 Hz to 33 MHz
4. 256 x 8-bit Internal RAM.
5. 32 Programmable I/O Lines.
6. Three 16-bit Timer/Counters.
7. Eight Interrupt Sources.
8. Full Duplex UART Serial Channel.

2.2 Power Supply

The regulated power supply is provided as an input to the circuit with a voltage of 5V to the microcontroller. An A.C. input i.e., 230 V from the mains supply is fed to a rectifier after stepping the A.C input down to 12V by the transformer. A pulsating D.C voltage is obtained from the rectifier as an output which is fed to a filter to obtain a pure D.C voltage by removing existing A.C components left after rectification. Now, this voltage is fed to a voltage regulator to obtain a pure constant dc voltage in which an IC 7805 is used as a voltage regulator to get a 5V output Voltage.

2.3 Crystal Oscillator

A crystal oscillator is an electronic oscillator circuit that uses the mechanical resonance of a vibrating crystal of piezoelectric material to create an electrical signal with a very precise frequency.

This frequency is commonly used to keep track of time (as in quartz wrist watches), to provide a stable clock signal for digital integrated circuits, and to stabilize frequencies for radio transmitters and receivers. The most common type of piezoelectric resonator used is the quartz crystal. Therefore, oscillator circuits designed around them are named as "crystal oscillators". This block provides necessary frequency sine wave to the micro controller which is converted to square wave within the micro controller.

2.4 Inputs from Loco

The inputs such as VCD Acknowledgement (VCD Ack), Horn, Notch AV, Notch BV and Brake are given by the driver while driving to the microcontroller

2.5 Control Reset

Control reset executes the entire VCD cycle from beginning.

2.6 Liquid Crystal Display (LCD)

LCD (Liquid Crystal Display) screen is an electronic display module which provides a wide range of applications. A 16x2 LCD means it can display 16 characters per line and there are 2 such lines similarly a JHD 16x2A LCD displays each character in 5x7 pixel matrix. The schematic diagram of 16x2 LCD is shown in Fig.2. This LCD has two registers, namely, Command and Data, of which the commands are stored by command register and data is stored by data register. A command is an instruction given to LCD to perform a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data is the ASCII value of the character to be displayed on the LCD. Some of the LCD command codes are listed in Table 1.

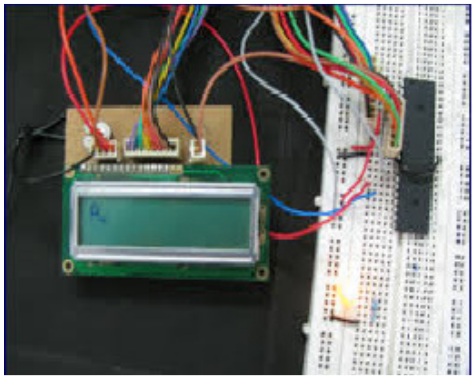

Fig.2: 16×2 LCD

Features:

1. Interface with either 4-bit or 8-bit microprocessor.
2. Display data RAM.
3. 80x8 bits (80 characters).
4. Character generator ROM and RAM.
5. 160 different 5x7 dot-matrix character patterns.
6. 8 different users programmed 5x7 dot-matrix patterns.
7. Numerous instructions.
8. Clear Display, Cursor Home, Display ON/OFF, Cursor.
9. ON/OFF, Blink Character, Cursor Shift, Display Shift.
10. Built-in reset circuit is triggered at power ON.

Table 1: LCD Command Codes

Code(Hex)	Command to LCD Instruction Register
01	Clear display of the screen
06	Automatic increment
38	2 line 5x7 Matrix
0F	Display is on and the cursor blinks
80	Force Cursor to begin from 1st line
C0	Force Cursor to begin from 2nd line

The LCD display is connected to the output port of micro controller to display the cyclic operations of vigilance control device.

2.7 Flashing LED

Light-emitting diodes are elements for light signalization in electronics. They are manufactured in different shapes, colors and sizes. For their low price, low consumption and simple use, they have almost completely pushed aside other light sources- bulbs at first place. They perform similar to common diodes with the difference that they emit light when current flows through them. Light emitting diodes (LEDs) are semiconductor light sources.

Based on semiconductor diode, LEDs emit photons when electrons recombine with holes on forward biasing. The forward voltage of LED (1.7V-2.2V) is lower than the voltage supplied (5V) to drive it in a circuit. Using an LED as such would burn it because a high current would destroy its p-n gate. Therefore a current limiting resistor is used in series with LED. The LED is interfaced to the output port of micro controller as the first indication to alert the driver.

2.8 Buzzer

Buzzer is an audio signaling device, which may be mechanical, electro-mechanical or electronic that sounds a warning of continuous or intermittent sound. It is compact and produces high sound pressure levels with minimal power consumption. The range of operating voltages is from 1 to 30V whilst sound output may be as high as 75 dB at 1m. Normally, buzzers operate a buzzing noise in the frequency range 300 to 500 Hz. This is used to alert the driver. The buzzer is connected to output port as a second indication to driver.

2.9 Relay

A relay is an electrically controllable switch widely used in industrial controls, automobiles and appliances. A relay is able to control an output circuit of higher power than the input circuit. Relays are devices which allow low power circuits to switch a relatively high Current/Voltage ON/OFF. For a relay to operate a suitable pull-in & holding current should be passed through its coil. Generally relay coils are designed to operate from a particular voltage often its 5V or 12V. The relay used is 5-pin relay to drive motor as an indication for movement of train.

2.10 DC Motor

DC (direct current) motors convert electrical pulses to mechanical movement. Maximum speed of DC motor is indicated in RPM. The RPM is reduced when moving a load and it decreases as the load increases.

The permanent magnet DC motor can be modeled as a device that produces torque proportional to the current flowing through it. It also produced a voltage proportional to the rotational velocity. The RPM of a motor is proportional to the voltage across its terminals. The motor will spin up in speed until the generator portion of the motor model matches the supply voltage. At that point no more current will flow into the motor and it will produce zero torque. Of course, there is some amount of friction, so there will be some amount of torque required to spin the motor, thus some amount of current needed. This current causes a voltage drop across the small series resistance in motor model. This voltage drop takes away from supply voltage and causes the motor to spin a bit slower than the supply voltage would indicate.

Specifications of DC Motor are:

1. Output RPM: 500 rpm
2. Input Voltage: 12 V
3. Current: 500 - 600 Ma
4. Shaft length RF

2.11 MAX232

The microcontroller can communicate with the serial devices using its single serial port. The logic levels at which this serial port operates is TTL logics. But some of the serial devices operate at RS 232 logic levels. So in order to communicate the microcontroller with modem, a mismatch between the logic levels occurs. In order to avoid this mismatch, in other words to match the Logic levels, a serial driver is used. A MAX232 is a serial line driver used to establish communication between modem and microcontroller. The interfacing of GSM modem with microcontroller using MAX 232 as a serial line driver is shown in Fig.3.The voltage levels of Max 232 are given in Table 2.

Table 2: Voltage levels of Max 232

RS232 Line Type & Logic Level	RS232 Voltage	TTL Voltage to/from MAX232
Data Transmission (Rx/Tx) Logic 0	+3 V to +15 V	0V
Data Transmission (Rx/Tx) Logic 1	-3 V to -15 V	5V
Control Signals (RTS/CTS/DTR/DSR) Logic 0	-3 V to -15 V	5V
Control Signals (RTS/CTS/DTR/DSR) Logic 1	+3 V to +15 V	0V

2.12 Global System for Mobile communication (GSM)

A GSM modem is a wireless modem that works with a GSM wireless network which behaves like a dial-up modem. The main difference between them is that a dial-up modem sends and receives data through a fixed telephone line while a wireless modem sends and receives data through radio waves and operates at either the 900MHz or 1800MHz frequency band. Voice calls and data transfer speeds of up to 9.6kbits/s, together with the transmission of SMS (Short Message Service)are supported. The GSM Modem comes with a serial interface and controlled using AT command interface. The interfacing of GSM modem with the microcontroller is shown in Fig.3.

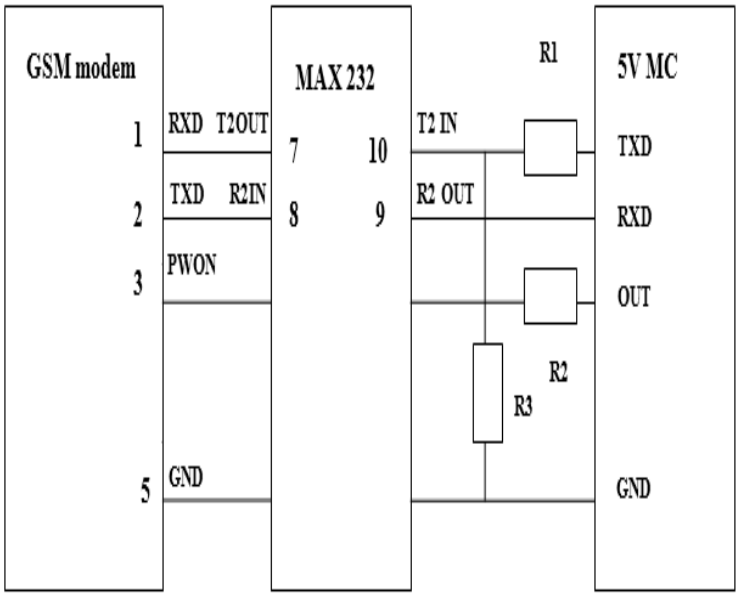

Fig.3: Interfacing of GSM modem with microcontroller

Here a GSM modem SIMCOM made SIM300 V 7.03 interfaced with the microcontroller operates in 900MHz frequency and is operated at voltage levels of 3.5 to 5V.The modem is provided with network status indication LED lamp and buzzer to indicate incoming call. The GSM modem is shown in Fig.4.

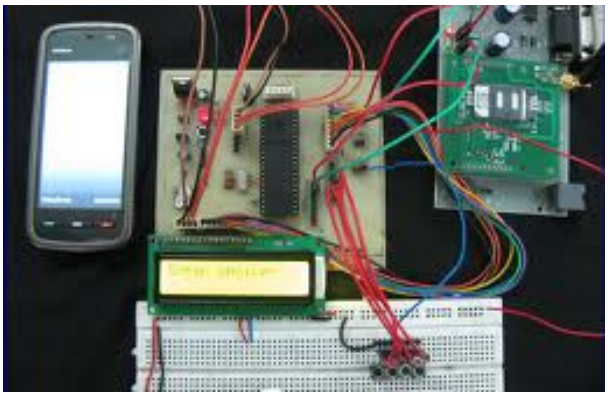

Fig.4: GSM Modem

The working of GSM modem is based on commands, always start with AT (which means Attention) and finish with a <CR> character. AT commands are used to control the MODEMs. Only a subset of the AT command set needs to be implemented, since one of the main objective for this application is to show how to send the message. PC or controller specifies the AT commands to the GSM modem. Some of the AT commands used are listed in Table 3.

Table 3: AT Command Set

Command	Description
AT	Check communication between the module and the computer
AT+CMGF	Set the SMS mode (Either text or protocol data unit mode)
AT+CMGW	Store message in the SIM
AT+CMGS	Send message to a given phone number
ATD	Dial or Call a number
ATA	Answer a Call
ATH	Disconnect remote user link with the GSM module

2.13 Global Positioning System (GPS)

The Global Positioning System (GPS) is a satellite based navigation system that sends and receives radio signals which are acquired by a GPS receiver and provides the user with information. Using GPS technology one can determine location, velocity and time, 24 hours a day, in any weather conditions anywhere in the world for free. GPS was formally known as the NAVSTAR (Navigation Satellite Timing and Ranging). A set of 24 satellites that are continuously orbiting the earth serves the basis of the GPS technology which are equipped with atomic clocks to send out radio signals for exact time and location. The GPS receiver attain these radio signals from the satellites. Once the GPS receiver locks on to four or more of these satellites, it can triangulate its location from the known positions of the satellites. This model provides high performance, low power, cost effective and portable system which accurately detects the location. The GPS receiver used in this model is Sky Traq Venus 6 GPS module ST22 which encompass TTL logics and also RS232 as option. The GPS receiver is shown in Fig.5. This GPS is used to track the position of the train after the emergency brake is applied in order to avoid the accidents and this application is used only after the train is stopped.

GPS Receiver Specifications:

1. 65 channels-1Hz Update rate
2. Hot Start- 1sec
3. Baud rate- 9600bits/s
4. Operating Voltage-5Volts dc
5. O/P Format-NMEA 0183-RS232
6. O/P Format-NMEA 0183-RS232
7. Operating Temperature: -40 to +85^{o}C
8. Sensitivity- Tracking: -160 dBm
   Reacquisition: -158 dBm
   Cold Start (Autonomous): -148 dBm

Fig.5: GPS Receiver

3. WORKING

VCD a microcontroller based equipment designed and manufactured to enhance the safety of the locomotive operation by ensuring the alertness of the crew all the time, consisting a system with resetting type that can be operated in a fail-safe manner. VCD will give cyclic warnings to the driver based on the drivers reaction to these warnings (in terms of pre-defined set of actions to be done by the driver), the system will automatically reset the alerting cycle.

Major accidents in trains are due to fail of speed control in trains and due to un alertness of driver. by placing track monitoring system, we can also manage the speed by sending information to the micro controller in engine. Depending upon the vibrations of track the speed of the train also reduces or increases. Due to this we can prevent accidents in turnings of train tracks. If driver is not alert the microcontroller will operate alarm in engine. If driver is alert he will acknowledge the signal. If driver further fails to acknowledge the alarm, VCD will initiate the automatic application of brakes and it informs the position of the train where it is stopped in the form of latitude and longitude through GSM by using GPS module and sends the information to signal inspector as "TRAINSTOPPED".

4. CONCLUSION

The percentage of people travelling in trains has been increased when compared to the buses or any other transportation means. So, the safety measures for the passengers should also be taken care .This paper a vigilance control device improves vigilance and offers warning and brake application signals in a predefined manner. By, which we can ensure the safety of the passengers. With this device we can analyze that whether the accident is due to loco pilot i.e., Engine driver or due to failure of locomotive. By using this device we can inform the action of the driver to the higher

authorities if he fails to respond the cyclic warnings and the position of the train can also find to avoid the accidents. The high priority is given to the lives of people. Hence this paper provides a feasible solution to reduce accidents due to human failure.

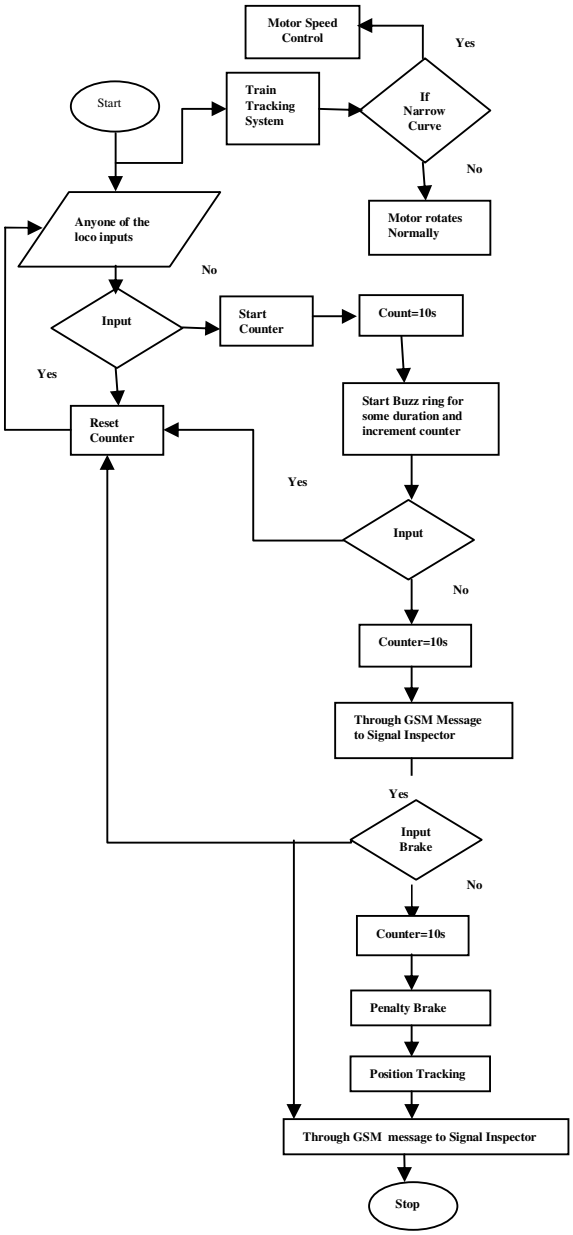

Fig.6: Flow Chart of the System

The flow chart shown in Fig.6 gives the clear explanation of the working of the modern vigilance control device. By using this flow chart the source code is developed. The source code is written in embedded C language.

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